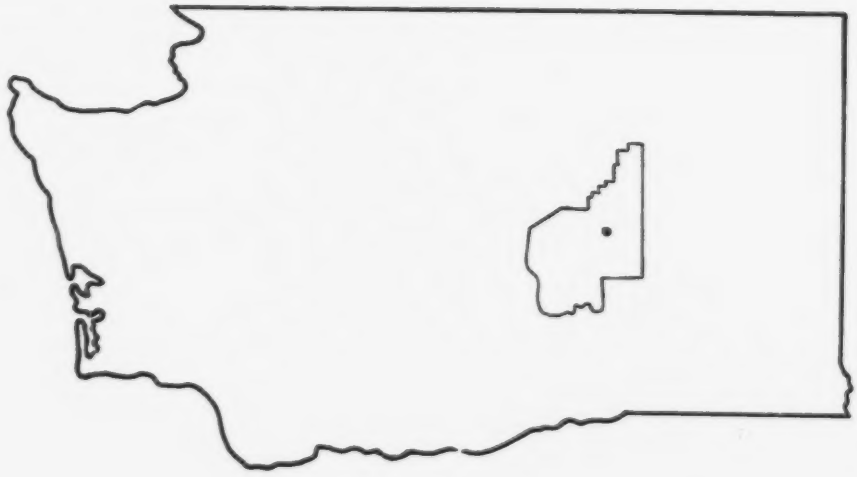
NOV 19 1993

FEMA 1269538053

FLOOD INSURANCE STUDY

CITY OF MOSES LAKE, WASHINGTON
GRANT COUNTY



JANUARY 5, 1989

Federal Emergency Management Agency

COMMUNITY NUMBER - 530053

NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program have established repositories of flood hazard data for floodplain management and flood insurance purposes. This Flood Insurance Study may not contain all the data available within the repository. Please contact the community repository for any additional data.

TABLE OF CONTENTS

		Page
1.0	INTRODUCTION	1
	1.1 Purpose of Study	1
	1.2 Authority and Acknowledgments	1
	1.3 Coordination	1
2.0	AREA STUDIED	2
	2.1 Scope of Study	2
	2.2 Community Description	2
	2.3 Principal Flood Problems	4
	2.4 Flood Protection Measures	4
3.0	ENGINEERING METHODS	5
	3.1 Hydrologic Analyses	5
	3.2 Hydraulic Analyses	6
4.0	FLOODPLAIN MANAGEMENT APPLICATIONS	7
	4.1 Floodplain Boundaries	7
	4.2 Floodways	7
5.0	INSURANCE APPLICATION	8
6.0	FLOOD INSURANCE RATE MAP	10
7.0	OTHER STUDIES	11
8.0	LOCATION OF DATA	11
9.0	BIBLIOGRAPHY AND REFERENCES	11

TABLE OF CONTENTS (cont.)

FIGURES

	Page
Figure 1 - Vicinity Map	3
Figure 2 - Floodway Schematic	10

TABLES

Table 1 - Historic Floods	4
Table 2 - Summary of Discharges	6
Table 3 - Floodway Data Table	9

EXHIBITS

Exhibit 1 - Flood Profiles

Parker Horn Panel 01P

Exhibit 2 - Flood Insurance Rate Map

Exhibit 3 - Elevation Reference Marks

FLOOD INSURANCE STUDY
CITY OF MOSES LAKE, GRANT COUNTY, WASHINGTON

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the City of Moses Lake, Grant County, Washington, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates and to assist the community in its efforts to promote sound floodplain management. Minimum floodplain management requirements for participation in the National Flood Insurance Program (NFIP) are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some states or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the State (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgments

The sources of authority for this Flood Insurance Study are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study were performed by U.S. Department of the Army, Corps of Engineers (COE), Seattle District, for the Federal Emergency Management Agency (FEMA), under Interagency Agreement No. IAA-EMW-E-1153, Project Order No. 1. This study was completed in September 1984.

1.3 Coordination

The streams to be studied were identified during a July 1982 meeting among representatives of the City of Moses Lake, FEMA, and the study contractor.

Requests for relevant information concerning flood hazards in the City of Moses Lake were sent to the Chairman of the Grant County Board of Commissioners, and to the Mayor of Moses Lake. A similar request was published in The Odessa Record on September 29, 1983. No new flooding data was discovered.

The results of the study were reviewed at the final community coordination meeting held on August 7, 1987. This meeting was attended by representatives of the community, FEMA, and the study

contractor. No significant changes resulted from this meeting, and the results were acceptable to the community.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated areas of the City of Moses Lake, Grant County, Washington. The area of study is shown on the Vicinity Map (Figure 1).

The area studied by detailed methods includes the reach of Crab Creek between the Alder Street Bridge and the U.S. Geological Survey (USGS) streamgaging station located 4.3 miles upstream.

The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development or proposed construction through 1989.

Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to, and agreed upon by, FEMA and the City of Moses Lake.

2.2 Community Description

The City of Moses Lake is located in eastern Grant County in eastern Washington and is situated approximately 100 miles west of Spokane, Washington. According to U.S. Census Bureau data (Reference 1), the population increased from 10,310 in 1970 to 10,629 in 1980.

Most of the city has been developed. Within the floodplain studied, development consists of farm facilities and pasture, single-family residences, small businesses, as well as warehouse and railroad facilities.

The City of Moses Lake is situated within the Crab Creek basin. Crab Creek flows from the north into the Parker Horn of Moses Lake.

The Crab Creek basin, in the rain shadow of the Cascade Mountains, has an arid to semiarid climate with little precipitation, hot summers, and cold winters. Mean annual precipitation ranges from 8 to 17 inches with most of the precipitation occurring during the winter. Summer rainfall is sometimes associated with thunderstorms which occur on about 10 to 15 days each summer, usually as isolated cells covering only a few square miles. Mean seasonal snowfall ranges from 15 to 50 inches. Temperatures have ranged from as high as 113°F to as low as -30°F.

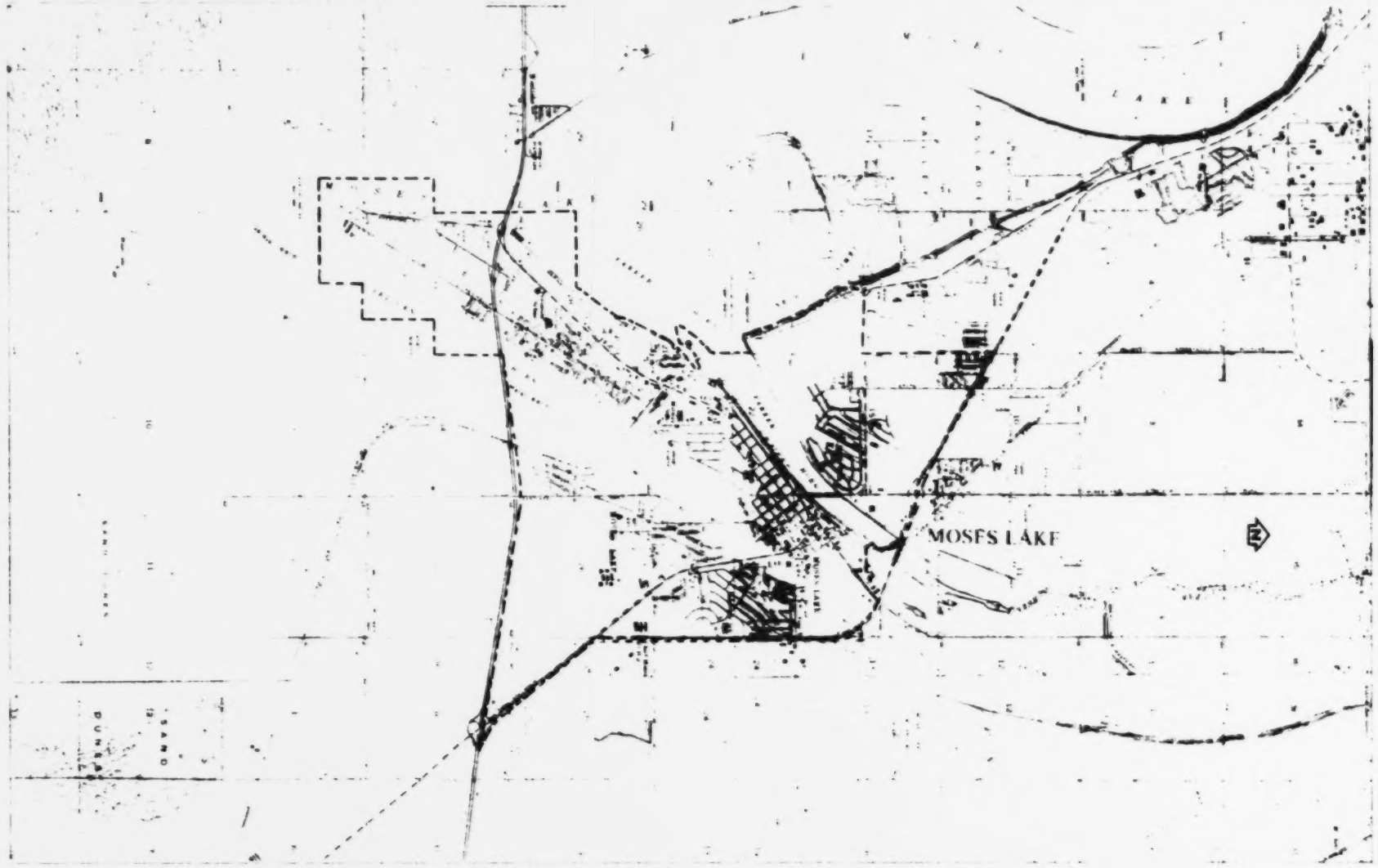


FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF MOSES LAKE, WA
(GRANT CO.)

APPROXIMATE SCALE

1 0 1 2 3 MILES

VICINITY MAP

The mean annual precipitation for Moses Lake is 8.1 inches. The mean annual snowfall is 15.8 inches. Average summer temperatures range from 81.8°F to 49.3°F. Average winter temperatures range from 36.6°F to 20.5°F (Reference 2).

2.3 Principal Flood Problems

The primary flood threat at Moses Lake is from Crab Creek exceeding the channel capacity in the upper reaches of Parker Horn. Rising lake elevations from large-volume flood events can also inundate areas adjacent to the lake. Most flooding problems in the Crab Creek basin occur from extreme runoff events of short duration. These flash floods are usually caused by heavy rain on snow-covered frozen ground. This type of event will be referred to as winter rainflood in this study. Severe spring and summer thunderstorms can also cause extensive flooding.

Several floods have occurred on Crab Creek at Moses Lake since 1900 (Reference 3). They are tabularized below:

Table 1. Historic Floods Since 1900

	Peak Flows cubic feet per second	Estimated Recurrence Interval
February 1932	10,000[1]	65
February 1957	10,400	65
January 1959	5,000	20
February 1963	4,200	16

[1] Although No Measurement Was Made of the 1932 Flood, Longtime Local Residents Recall it Having a Magnitude Similar to the 1957 Flood.

The February 1957 flood, which was the flood of record at Moses Lake, damaged bridges, but Crab Creek did not overflow its banks within the city. The channel through town could have carried another 2 to 3 feet of water. The flood damaged the Alder Street and State Highway 17 bridges by eroding the fill material and washing out the abutments. Floating ice aggravated the flooding by creating dams at the bridges, forcing backwater to inundate land adjacent to Crab Creek.

2.4 Flood Protection Measures

No measures have been taken to mitigate flooding problems at Moses Lake. Some floodproofing and building restrictions have been implemented. The lake elevation is usually lowered at the end of the fall irrigation season to make room for runoff, to protect the boat docks from winter ice, and to clean up the beaches.

3.0 ENGINEERING METHODS

For the flooding sources studied by detailed methods in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10-, 2-, 1-, and 0.2-percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (1-percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish peak discharge-frequency relationships for each flooding source studied by detailed methods affecting the community.

Although thunderstorms can occur in the Crab Creek basin, the large drainage area and stream length and the large amount of natural channel and overbank storage cause the peak to attenuate before reaching Moses Lake. The generally small volume of runoff associated with a thunderstorm would cause only a minimal rise in the lake elevation. Due to these factors, only winter rainfloods were considered in determining the discharge-frequency relationships for Crab Creek at Moses Lake.

A regional winter rainflood relationship was developed following established guidelines (References 4, 5, and 6) by analyzing the peak flows from 25 USGS streamgaging stations for hydrologically similar watersheds in the Columbia River basin. The peak runoff data from one of these gages (Crab Creek near Moses Lake, USGS Station No. 12467000 with records since 1942) is more representative of the Crab Creek basin than the regional relationship. This gage accounted for the tendency of streamflows to reduce in magnitude between the cities of Wilson Creek and Moses Lake. A statistical analysis of the Crab Creek near Moses Lake streamgage data, following the standard log-Pearson Type III method (Reference 4), was used to develop the winter rainflood discharge-frequency curves for Crab Creek at Moses Lake.

Peak discharge-drainage area relationships for Moses Lake are shown in Table 2.

Table 2. Summary of Discharges

Flooding Source and Location	Drainage Area (square miles)	Peak Discharges (cubic feet per second) 10-Year	50-Year	100-Year	500-Year
Crab Creek					
Below Confluence With Rocky Coulee Wasteway	2,306	3,300	9,450	14,100	32,700
At USGS Gaging Station 3 Miles North of Moses Lake	2,009	2,960	8,800	13,200	31,000

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals.

Cross sections for backwater analysis of the streams in the study area were obtained from aerial photographs flown on March 16, 1983, at a scale of 1:12,000. All bridges, dams, and culverts were field checked to obtain elevation data and structural geometry.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments where a floodway was computed (Section 4.2), selected cross section locations are also shown on the Flood Insurance Rate Map (Exhibit 2).

Roughness factors (Manning's "n") used in the hydraulic computations were chosen using engineering judgment and field observations of the streams and floodplain areas. Roughness values for the main channel of Crab Creek ranged from 0.030 to 0.06, while floodplain roughness values range from 0.035 to 0.050.

Water-surface elevations for floods of the selected recurrence intervals were computed through use of the COE HEC-2 Water-Surface Profiles computer program (Reference 7). Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals. Starting water-surface elevations for Crab Creek were calculated using the slope-area method.

The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD). Elevation reference marks used in this study are shown on the maps; the descriptions of the marks are presented in Elevation Reference Marks (Exhibit 3).

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages state and local governments to adopt sound floodplain management programs. Therefore, each Flood Insurance Study provides 100-year flood elevations and delineations of the 100- and 500-year floodplain boundaries and 100-year floodway to assist communities in developing floodplain management measures.

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent annual chance (100-year) flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent annual chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, the 100- and 500-year floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps at a scale of 1:4,800, with a contour interval of 4 feet (Reference 8).

The 100- and 500-year floodplain boundaries are shown on the Flood Insurance Rate Map (Exhibit 2). On this map, the 100-year floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A and AE); and the 500-year floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 100- and 500-year floodplain boundaries are close together, only the 100-year floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

For the streams studied by approximate methods, only the 100-year floodplain boundary is shown on the Flood Insurance Rate Map (Exhibit 2.)

Approximate 100-year floodplain boundaries in some portions of the study area were taken directly from the Flood Hazard Boundary Map (Reference 9).

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting

increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 100-year floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the 100-year flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

The floodways presented in this study were computed for certain stream segments on the basis of equal conveyance reduction from each side of the floodplain. Floodway widths were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. The results of the floodway computations are tabulated at selected cross sections (Table 3). In cases where the floodway and 100-year floodplain boundaries are either close together or collinear, only the floodway boundary has been shown.

The area between the floodway and 100-year floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 2.

5.0 INSURANCE APPLICATION

For flood insurance rating purposes, flood insurance zone designations are assigned to a community based on the results of the engineering analyses. These zones are as follows:

Zone A

Zone A is the flood insurance rate zone that corresponds to the 100-year floodplains determined in the Flood Insurance Study by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no base flood elevations or depths are shown within this zone.

Zone AE

Zone AE is the flood insurance rate zone that corresponds to the 100-year floodplains determined in the Flood Insurance Study by detailed methods. Whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE
Parker Horn								
A	0	145	1,838	7.7	1051.3	1051.3	1052.3	1.0
B	2,960	516	6,024	2.3	1053.3	1053.3	1054.1	0.8

[1]Feet Above Cross Section A

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

MOSES LAKE, WA
(GRANT CO.)

FLOODWAY DATA

PARKER HORN

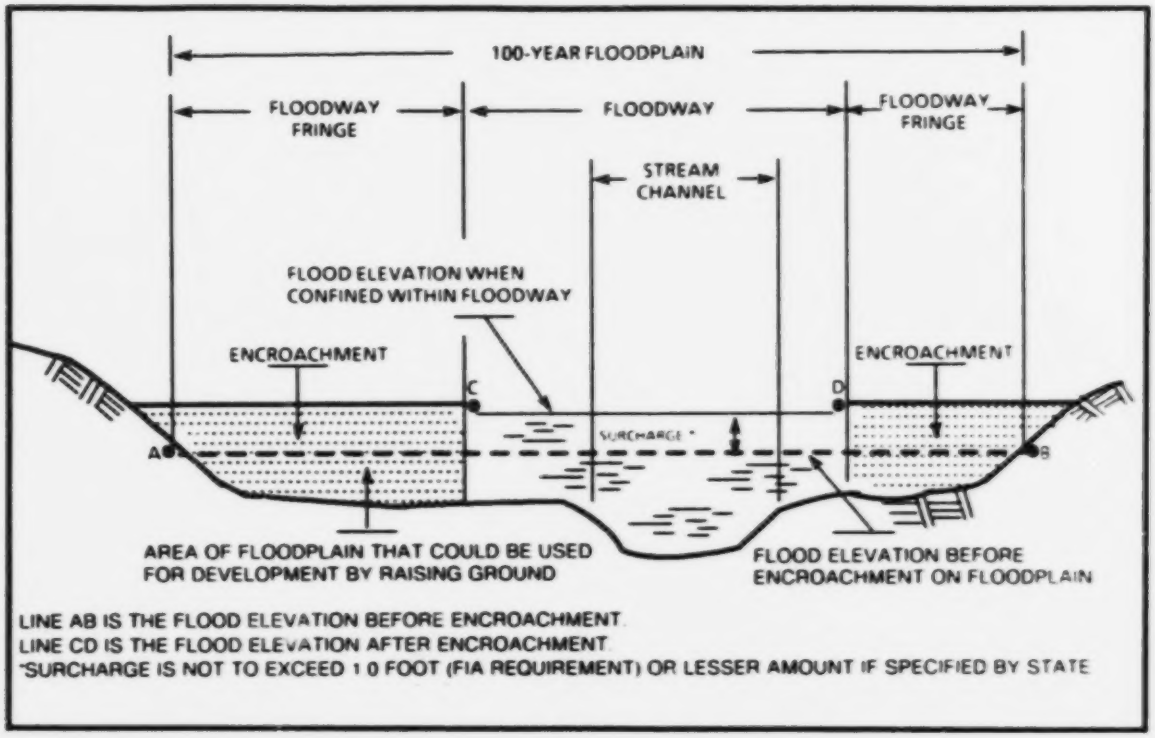

100-YEAR FLOODPLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
A
B
SURCHARGE *
AREA OF FLOODPLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOODPLAIN
LINE AB IS THE FLOOD ELEVATION BEFORE ENCROACHMENT
LINE CD IS THE FLOOD ELEVATION AFTER ENCROACHMENT
*SURCHARGE IS NOT TO EXCEED 1.0 FOOT (FIA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE

Figure 2. Floodway Schematic

Zone X

Zone X is the flood insurance rate zone that corresponds to areas outside the 500-year floodplain, areas within the 500-year floodplain, areas of 100-year flooding where average depths are less than 1 foot, areas of 100-year flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 100-year flood by levees. No base flood elevations or depths are shown within this zone.

6.0 FLOOD INSURANCE RATE MAP

The Flood Insurance Rate Map is designed for flood insurance and floodplain management applications.

For flood insurance applications, the map designates flood insurance rate zones as described in Section 5.0 and, in the 100-year floodplain that was studied by detailed methods, shows selected whole-foot base flood elevations or average depths. Insurance agents use the zones and base flood elevations in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

For floodplain management applications, the map shows by tints, screens, and symbols, the 100- and 500-year floodplain, floodway, and the locations of selected cross sections used in the hydraulic analyses and floodway computations.

7.0 OTHER STUDIES

A floodplain identification study of Moses Lake was completed in 1973 by Stevens, Thompson, and Runyan, Inc., Engineers and Planners (STR) for the Washington State Department of Ecology. The COE, Seattle District, reviewed the results of the STR study and found them to be acceptable. The STR study was then used as a basis to review the existing flood hazard boundary maps. This review indicated that the flood hazard boundary maps were adequate.

8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting the Natural and Technological Hazards Division, FEMA, Federal Regional Center, 130 228th Street, S.W., Bothell, Washington 98021-9796.

9.0 BIBLIOGRAPHY AND REFERENCES

1. U.S. Department of Commerce, Bureau of the Census, 1980 Census of the Population, Volume 1, Characteristics of the Population, September 1981.

2. Agricultural Extension Service, Washington State University, E.M. 2545, Washington Climate, Earl L. Phillips, Seattle, Washington, 1965.

3. U.S. Department of the Interior, Geological Survey, Water Resources Data, Washington, Gage No. 12467000, Crab Creek Near Moses Lake, WA, Water Years 1932, 1957, 1959, and 1963.

4. U.S. Department of the Army, Corps of Engineers, Statistical Methods in Hydrology, L. R. Beard, Sacramento, California, January 1962.

5. Interagency Advisory Committee on Water Data, Bulletin No. 17B, "Guidelines for Determining Flood Flow Frequency," March 1982.

6. U.S. Department of the Interior, Geological Survey, Open-File Report 74-336, Magnitude and Frequency of Floods in Washington, J. E. Cummans, M. R. Collins, and E. G. Nassar, Tacoma, Washington, 1975.

7. U.S. Army Corps of Engineers, Hydrologic Engineering Center, Computer Program 723-X6-1202A, HEC-2 Water Surface Profiles, Davis, California, November 1976, updated March 1982.

8. Federal Emergency Management Agency, Flood Hazard Boundary Map, City of Moses Lake, Washington, February 7, 1975.

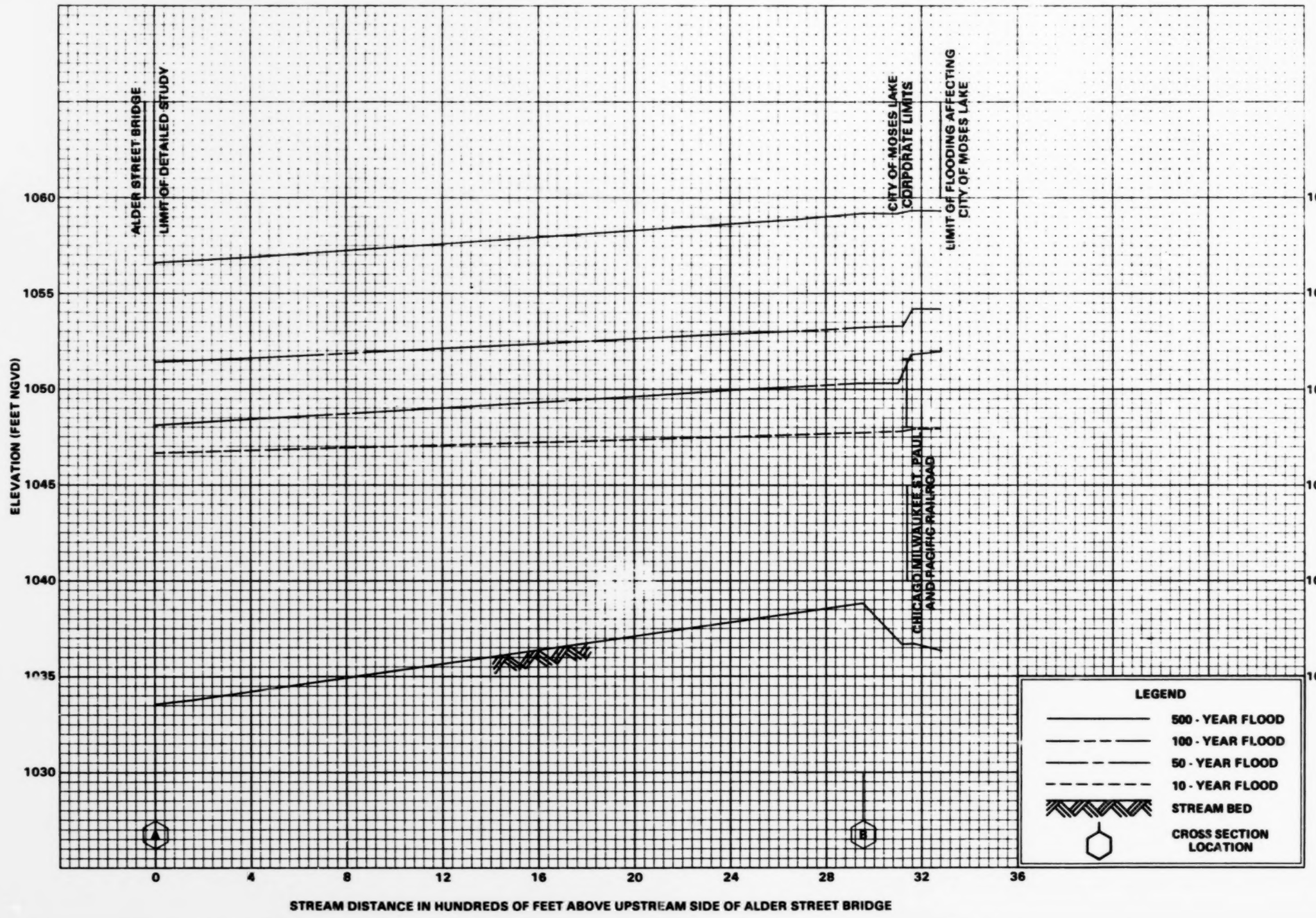
9. U.S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-2 Water-Surface Profiles Users Manual, Davis, California, September 1982.

Chow, Ven Te, Open Channel Hydraulics, New York: McGraw-Hill Book Company, 1959.

U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study Guidelines and Specifications, October 1977.

U.S. Department of the Interior, Geological Survey, Roughness Characteristics of Natural Channels, Water-Supply Paper 1849, 1967.

U.S. Department of Transportation, Federal Highway Administration, Hydraulics of Bridge Waterways, Hydraulic Design Series No. 1, 1970.



FLOOD PROFILES

PARKER HORN

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF MOSES LAKE, WA
(GRANT CO.)

01P

Exhibit 3. Elevation Reference Marks
City of Moses Lake, Grant County, Washington

Reference Mark	Elevation (Ft. NGVD)	Description of Location

Not Yet Provided
By Study Contractor